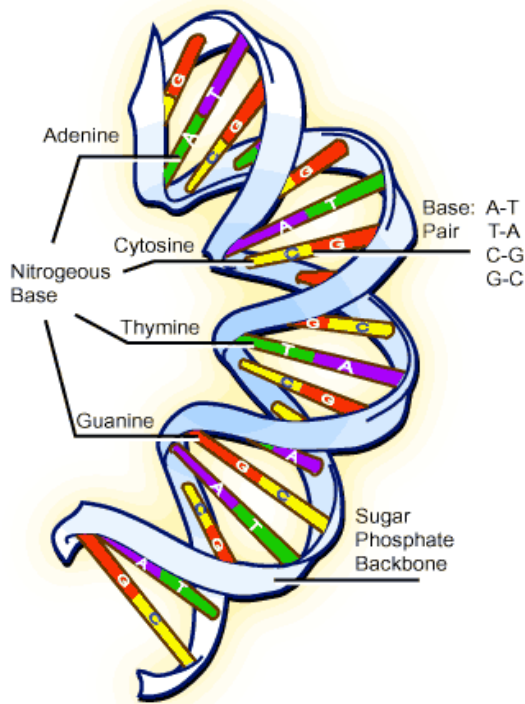


DNA – deoxyribonucleic acid



DNA is a double helix; a spiral staircase composed of thousands of **NUCLEOTIDES** on each side of the staircase.

Each nucleotide is made up of:

- A 5-carbon sugar called deoxyribose
- A phosphate group
- One of four different nitrogenous bases (adenine, guanine, cytosine, thymine)

Alternating sugar and phosphate groups make up the backbone of each side of the staircase

The nitrogenous bases make up the steps of the staircase, a base on one side has an attraction to a base on the other side of the staircase, but they can only have a certain pattern – **adenine (A) can only match with thymine (T), and guanine(G) can only match with cytosine(C).** The attraction between them is a hydrogen bond, which is a force that is not as strong as a chemical bond.

The pattern of the bases forms the genetic code. It even has special patterns that are used for punctuation.

The two sides are said to be complementary. Not only are the base pairs opposite, but the two strands are also antiparallel – that is, the phosphate groups run in opposite directions. One side runs 5' to 3' and the other runs 3' to 5'. These numbers refer to which of the five carbon atoms in deoxyribose the phosphate group is attached.

DNA REPLICATION

Remember DNA must replicate before any mitosis or meiosis. It must be able to copy itself both quickly and accurately.

During replication, two molecules are made from one by using half of the original DNA as a template.

Replication follows three stages and many special proteins called enzymes need to help the process:

1. INITIATION – a portion of the DNA helix is unwound (unzipped)
2. ELONGATION – the new strands are assembled
3. TERMINATION – the new DNA reforms into its helical pattern

In addition, after the replication is complete, proofreading and possible correction takes place.

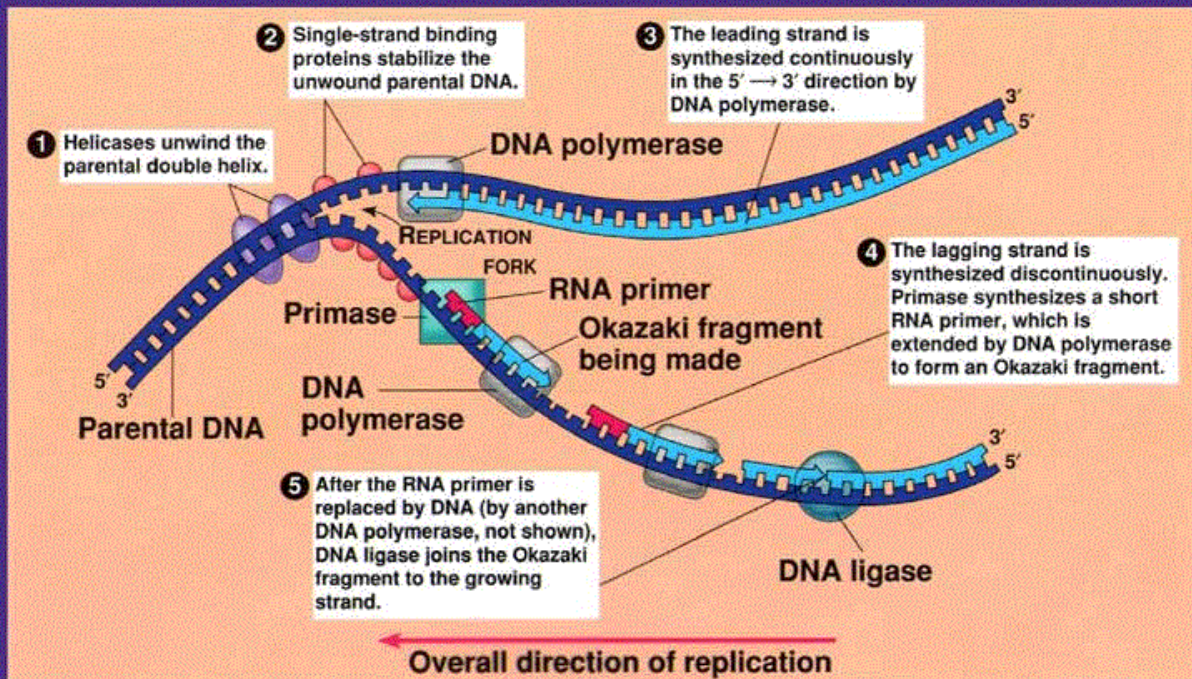
INITIATION begins when a set of enzymes called **helicases** split and unravel sections along the parent DNA.

ELONGATION takes place differently on each strand, as shown in the diagram. **DNA polymerases** (enzymes) add nucleotides to the open DNA in the 5' to 3' direction continuously.

On the other strand, called the lagging strand, replication is in sections, not continuous. An enzyme called **primase** starts up a short temporary primer, which is extended by DNA polymerase to form what is called an Okazaki fragment. The primer then gets replaced by a correct DNA nucleotide by another DNA polymerase, and the Okazaki fragments are joined together by yet another enzyme, **ligase**

Once the newly formed strands are complete, the daughter DNA strands rewind on their own. Enzymes are not needed for this step, called TERMINATION.

A SUMMARY OF DNA REPLICATION



It is during termination that a problem arises, since the DNA must be replicated from 5' to 3', some nucleotides end up unpaired and will break off from the strand. **This results in a loss of base pairs every time there is replication, about 100 in humans!!** This constant loss of genetic material could be disastrous for the cell, so there are special regions called **telomeres** at the end of each chromosome. Telomeres are long sections of repetitive bases that do not function in cell development, but take up space.

There are limits to telomeres, and cells that live the longest have the most. Once they are gone, the cell cannot replicate anymore

The enzyme DNA polymerase also has another function – it proofreads the base pairs to see if they are hydrogen bonded together. If not it can insert the correct base to make the pair. This double check brings the accuracy of replication to about ONE ERROR PER BILLION BASE PAIRS!

Typical types of public exam questions on DNA:

What percent of guanine would be found in a strand of DNA containing 28% cytosine?

- (A) 22%
- (B) 28%
- (C) 44%
- (D) 56%

What are the components of DNA?

- (A) phosphate group, nitrogenous base, deoxyribose sugar
- (B) phosphate group, nitrogenous base, ribose sugar
- (C) phosphate group, polypeptides, deoxyribose sugar
- (D) phosphate group, polypeptides, ribose sugar

Which is a function of DNA polymerase?

- (A) cleaves and unwinds the double helix
- (B) joins Okazaki fragments together
- (C) proofreads base pairing
- (D) synthesizes an RNA primer to begin elongation